PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Umatilla Hatchery Monitoring And Evaluation

BPA project number: 9000500
Contract renewal date (mm/yyyy): 11/2000 ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Oregon Department of Fish and Wildlife

Business acronym (if appropriate) ODFW

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
7.0C.4, 7.2D, 7.2D.1, 7.4I, 7.4I.1, 7.4L, 7.4L.1

FWS/NMFS Biological Opinion Number(s) which this project addresses
This project relates to the Biological Opinion for 1995-98, hatchery operations in the Columbia River, section 7 consultation, Endangered Species Act: 1) wire tag 100% of fall chinook, 2) provide straying information, 3) implement fish health inspections.

Other planning document references
Monitoring activities are called for in A Comprehensive Plan for Rehabilitation of Anadromous Fish Stocks in the Umatilla River Basin (Boyce 1986); the Umatilla Hatchery Master Plan (ODFW and CTUIR 1990); the Umatilla River Subbasin Salmon and Steelhead Plan (ODFW and CTUIR 1989); and, Umatilla Basin Project-Initial Project Workplan (USBR and BPA 1989). The Wy Kan Ush Me Wa Kush Wit plan calls for continuation of current monitoring of all artificial production actions in the Umatilla basin (volume II, page 45)

Short description
Evaluate juvenile rearing, marking, tagging, survival, stock life history, fish health, mass marking, straying, sport fishing and catch contribution for salmon and steelhead reared in oxygen supplemented and standard raceways at Umatilla Hatchery.

Target species
Spring Chinook Salmon, Fall Chinook Salmon, Summer Steelhead

Section 2. Sorting and evaluation

Subbasin
Lower Mid-Columbia

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☐ Resident fish ☐ Wildlife	☒ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☐ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20516	Umatilla Subbasin
8903500	Umatilla Hatchery O&M
8343500	Umatilla Hatchery Satellite Facilities O&M
8902401	Umatilla RiverJuvenile Salmonid Outmigration and Survival M&E
9000501	Umatilla River Natural Production M&E

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
8903500	Umatilla Hatchery O&M	Rearing facility for test fish.
8343500	Umatilla Satellit Facilities O&M	Rearing and acclimation sites.

8802200	Umatilla Fish Passage Operations	This project provides low water passage for fish in the Umatilla River monitors fish passage facility operation, and collects information on adult fish trapped at river mile 3.0.
843600	Umatilla Fish Passage Facility O&M	Coordination
871001	Enhance Anadromous Fish Habitat	Information exchange

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1996	Completed tagging, growth, and juvenile migration monitoring for five broods of subyearling fall chinook salmon (CHF0) reared in Michigan (MI) and Oregon (OR) raceways; coded-wire-tag (CWT) recovery from adults has been completed for two broods.	Objective 1: Showed similar rearing and migration success of subyearlings reared in MI vs OR raceways. Adult survial and data analysis will be completed in 2002.
1998	Completed tagging, growth, and juvenile migration monitoring for two broods of CHF0 reared at three different densities; CWT recovery is incomplete for all broods.	Objective 2: Showed similar rearing and migration success for juveniles reared at three densities. Adult survival and data analysis will be completed in 2006.
1998	Completed tagging and juvenile migration monitoring for two broods of yearling fall chinook salmon (CHF1) reared in MI and OR raceways at Umatilla Hatchery and seven broods reared at other hatcheries; CWT recovery is incomplete for all broods.	Objective 3: Showed similar rearing and migration success for juveniles reared in MI and OR raceways. Used CWT data to compare subyearling and yearling release strategies. Adult survival data will be completed in 2005.
1998	Completed seven years of marking and wire-tagging fall chinook salmon (all rearing strategies) to monitor straying rates into Snake River.	Objective 4: Used CWT data to show that stray fall chinook salmon were successfully separated from Snake River stock.
1998	Completed marking and wire-tagging of three broods of CHF0 to determine effects of mark and tag on smolt-to-adult survival; CWT recovery was completed in 1998.	Objective 5: Determined success of body tags as a mass mark. Analysis will be completed in 1999.
1998	Completed tagging, growth, and juvenile migration monitoring for three broods of subyearling spring salmon (CHS0) reared	Objective 6: Monitored rearing and adult survival of subyearlings. Program eliminated becasue of poor

	in MI and/or OR raceways and released in the spring; CWT recovery for two broods was completed in 1998.	growth and adult survival.
1998	Completed tagging and juvenile migration monitoring for three broods of fall-released (CHS0) reared at Umatilla and Bonneville hatcheries; CWT recovery for the first brood was completed in 1998.	Objective 7: Showed similar juvenile performance for fish reared at Umatilla and Bonneville hatcheries Analysis of adult data will be completed in 2001.
1998	Completed tagging and juvenile migration monitoring for three broods of yearling spring chinook salmon (CHS1) reared in MI and OR raceways and released in the spring; CWT recovery for the first brood was completed in 1998.	Objective 8: Showed simlar juvenile rearing and migration performance for fish reared in MI vs OR raceways Adult survival data will be complete in 2002.
1998	Completed tagging and juvenile migration monitoring for five broods of spring-released CHS1 reared concurrently at Umatilla Hatchery and Bonneville or Carson or Little White Salmon hatcheries; CWT recovery for one brood was completed in 1998.	Objective 9: Changed rearing program and profile for smolts reared at Umatilla Hatchery based on poor adult survival compared to smolts reared at Bonneville. Adult data from current groups will be complete in 2005.
1998	Completed tagging, growth, and juvenile migration monitoring for seven broods of steelhead (STS) reared in MI raceways; CWT recovery for three broods was completed in 1998.	Objective 10: Identified differential adult survival for groups released in April and May. Adult data from current groups wil be complete in 2003.
1998	Completed seven years of weekly water quality monitoring in MI and OR raceways associated with varying fish production strategies.	Objective 11 met: Monitored water quality in MI and OR raceways associated with varying fish production strategies.
1998	Completed six years of salmon and steelhead creel surveys and harvest estimates for Umatilla River sport fishery.	Objective 13 met: Estimated angler effort and salmon and steelhead harvest in Umatilla River sport fishery.
1998	Completed six years of Hatchery Fish Production planning and coordination activities for Umatilla Basin.	Objectived 14 met: Assisted with Hatchery Fish Production planning and coordination activities for Umatilla Basin.
1998	Completed six years of fish health and disease monitoring for fish released in the Umatilla River.	Objective 15 met: Monitored health and disease of fish released in the Umatilla River.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of CHF0 reared in MI and OR raceways.	a	Recover coded-wire tag data to assess survival, life history information, fishery contribution, and cost effectiveness.
2	Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of CHF0 reared at three densities in MI raceways.	a	Sample raceways to determine growth, food conversion, and smolt condition.
		b	Mark and release fish to determine juvneile migration success in the Umatilla and Columbia Rivers.
		c	Wire tag juveniles to determine adult survival, fishery contribution, and straying.
3	Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of CHF1 reared at three densities in MI raceways.	a	Sample raceways to determine growth, food conversion, and smolt condition.
		b	Sample raceways to determine growth, food conversion, and smolt condition.
		c	Wire tag juveniles to determine adult survival, fishery contribution, and straying.
4	Determine and compare straying of fall chinook salmon into the Snake and upper Columbia Rivers for all groups.	a	Mark subyearlings and yearlings, obtain adult recovery data and determine straying by rearing and release strategy.
5	Determine the effects of tagging and marking on smolt-to-adult survival of CHF0.	a	Interrogate adult chinook returning to the Umatilla River and determine survival by mark group.
6	Determine and compare smolt-to-adult survival of CHS0 reared in MI and OR raceways.	a	Recover coded-wire tag data to determine adult survival, fishery contribution, and straying.
7	Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of CHS1 reared at	a	Recover coded-wire tag data to determine adult survival, fishery contribution, and straying.

	Umatilla and Bonneville hatcheries and released in the fall.		
8	Determine and compare rearing performance, smolt condition, juvenile migration, smolt-to-adult survival, life history characteristics, and cost effectiveness of CHS1 reared at Umatilla and Bonneville hatcheries and released in the spring.	a	Determine eyeing and hatching survival, fertilization success, hatching survial, and swim-up lengths among groups incubated at different temperatures.
		b	Sample raceways to determine growth, food conversion, and smolt condition.
		c	Mark and release fish to determine juvneile migration success in the Umatilla and Columbia Rivers.
		d	Recover coded-wire tag data to determine adult survival, fishery contribution, and cost effectiveness.
9	Monitor rearing performance, smolt condition, juvenile migration performance, smolt-to-adult survival, life history characteristics, and cost effectiveness of STS reared in MI raceways.	a	Sample raceways to determine growth, food conversion, and smolt condition.
		b	Mark and release fish to determine juvneile migration success in the Umatilla and Columbia Rivers.
		c	Recover coded-wire tag data to determine adult survival, fishery contribution, and cost effectiveness.
10	Monitor water quality in MI and OR raceways.	a	Monitor temperature, pH, oxygen, gas pressure, ammonia, and alkalinity to evaluate rearing conditions in standard and high density, multi-pass raceways.
11	Monitor annual recreational fishery for salmon and steelhead in the Umatilla River.	a	Estimate effort, catch, harvest, and number harvested by tag code for all recreational fisheries.
12	Participate in planning and coordination activities in the Umatilla basin.	a	Participate in technical work groups and task teams to ensure research findings and activities are incorporated into annual hatchery

			production plans.
13	Monitor and evaluate the health and disease status of salmon and steelhead reared at Umatilla Hatchery and adult broodstock providing gametes for the Umatilla program.	a	Monitor and evaluate the health of fish reared at Umatilla Hatchery.
		b	Implement disease control measures and recommend adjustments to rearing strategies.
		c	Monitor returning adults for R. salmoninarum.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	11/1999	10/2002	Determine and compare smolt-to-adult survival, life history, and cost effectiveness of CHF0 reared in MI and OR raceways.		5.00%
2	11/1999	10/2005	Determine and compare juvenile rearing and migration, smolt-to-adult survival, life history characteristics, and cost effectiveness of CHF0 reared at three densities in MI raceways.		33.00%
3	11/1999	10/2001	Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of CHF1 reared at three densities in MI raceways.		5.00%
4	11/1999	10/2005	Determine and compare straying of fall chinook salmon into the Snake and upper Columbia Rivers for all rearing strategies.		2.50%
5	11/1999	10/2005	Determine the effects of		2.50%

			tagging and marking on smolt-to-adult survival of CHF0.		
6	11/1999	10/2000	Determine and compare smolt-to-adult survival of CHS0 reared in MI and OR raceways.		2.50%
7	11/1999	10/2000	Determine and compare smolt-to-adult survival, life history, and cost effectiveness of CHS1 reared at Umatilla and Bonneville hatcheries and released in the fall.		5.00%
8	11/1999	10/2004	Determine and compare rearing performance, smolt condition, juvenile migration, smolt-to-adult survival, life history, and cost effectiveness of CHS1 reared at Umatilla and Bonneville hatcheries and released in the spring.		10.00%
9	11/1999	10/2002	Monitor rearing performance, smolt condition, juvenile migration performance, smolt-to-adult survival, life history, and cost effectiveness of STS reared in MI raceways.		5.00%
10	11/1999	10/2005	Summarize water quality monitoring in MI and OR raceways.		5.00%
11	11/1999	10/2005	Determine annual recreational fishery for salmon and steelhead in the Umatilla River.		7.00%
12	11/1999	10/2005	Participate in planning and coordination activities in the Umatilla basin.		5.00%
13	11/1999	10/2005	Monitor and evaluate health and disease status		12.50%

			of salmon and steelhead reared at Umatilla Hatchery and adult broodstock providing gametes for the Umatilla program.		
				Total	100.00%

Schedule constraints
Hatchery water shortages and low egg availability may restrict the number of experiments conducted each year. Risks to Snake River stocks are unknown. Poor adult returns and low tag recoveries may necessitate additional releases.

Completion date
2006

Section 5. Budget

FY99 project budget (BPA obligated): $674,808

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	costs are for FY99	%31	228,393
Fringe benefits	costs are for FY99	%11	85,321
Supplies, materials, non-expendable property	costs are for FY99	%24	176,746
Operations & maintenance	NA		0
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	costs are for FY99	%1	13,256
NEPA costs	NA		0
Construction-related support	NA		0
PIT tags	# of tags: 10,000	%4	29,000
Travel	costs are for FY99	%2	15,550
Indirect costs	costs are for FY99	%24	173,322
Subcontractor	NA		0
Other	costs are for FY99		0
TOTAL BPA FY2000 BUDGET REQUEST			$721,588

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Total project cost (including BPA portion)			$721,588

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$743,236	$765,532	$788,499	$812,154

Section 6. References

Watershed?	Reference
☐	Boyce, R.R. 1986. A comprehensive plan for rehabilitation of anadromous fish stocks in the Umatilla River basin. Report DOE/BP-18008-1, Bonneville Power Adminstration, Portland, Oregon.
☐	Carmichael, R.W. 1997. Straying of Umatilla River hatchery origin fall chinook salmon into the Snake River. In: Genetic Effects of Straying of Non-Native Hatchery Fish into Natural Populations (W.S. Grant, editor). NOAA, Seattle, WA.
☐	Contor, C.R., E. Hoverson, and P. Kissner. 1995. Umatilla basin natural production monitoring and evaluation. Annual progress report 1993-1994 to Bonneville Power Administration, Portland, Oregon.
☐	Contor, C.R., E. Hoverson, P. Kissner, and J. Volkman. 1996. Umatilla basin natural production monitoring and evaluation. Annual progress report 1994-1995 to Bonneville Power Administration, Portland, Oregon.
☐	Contor, C.R., E. Hoverson, P. Kissner, and J. Volkman. 1997. Umatilla basin natural production monitoring and evaluation. Annual progress report 1995-1996 to Bonneville Power Administration, Portland, Oregon.
☐	CTUIR (Confederated Tribes of the Umatilla Indian Reservation) and ODFW (Oregon Dept. of Fish and Wildlife). 1989. Umatilla River subbasin - salmon and steelhead plan. Prepared for the Northwest Power Planning Council for Columbia basin system planning.
☐	CTUIR (Confederated Tribes of the Umatilla Indian Reservation) and ODFW (Oregon Department of Fish and Wildlife). 1990. Umatilla hatchery master plan. Prepared for the Northwest Power Planning Council, Portland, Oregon.
☐	CTUIR (Confederated Tribes of the Umatilla Indian Reservation). 1994. Umatilla basin natural production monitoring and evaluation. Annual progress report 1992-1993 to Bonneville Power Administration, Portland, Oregon.

☐	Ewing, R.D., S.K. Ewing, and J.E. Sheahan. 1994. Willamette Oxygen Supplementation Studies. 1994 annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	Ewing, R.D., J.E. Sheahan, M.A. Lewis, and A.N. Palmisano. 1998. Effects of rearing density and raceway conformation on growth, food conversion, and survival of spring chinook salmon. Prog. Fish. Cult. 60:167-178..
☐	Focher, S.M., R.W. Carmichael, M.C. Hayes, and R.W. Stonecypher, Jr. 1997. Umatilla hatchery monitoring and evaluation. 1996 annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	Hayes, M.C., S.M. Knapp, and A.A. Nigro. 1992. Pages 53-103 in S.M. Knapp, editor. Evaluation of juvenile fish bypass and adult fish passage facilities at water diversions in the Umatilla River. Annual Report 1991. DOE/BP-10385-2, B.P.A., Portland, OR
☐	Hayes, M.C., R.W. Carmichael, S.M. Focher, N.L. Hurtado, M.L. Keefe, G.W. Love, W.J. Groberg, Jr., S.T. Onjukka, and K. Waln. 1996a. Umatilla Hatchery Monitoring and Evaluation. Annual Report to Bonneville Power Administration, Portland, Oregon.
☐	Hayes, M.C., R.W. Carmichael, S.M. Focher, W.J. Groberg, Jr., S.T. Onjukka, R.W. Stonecypher, Jr., and K. Waln. 1996b. Umatilla Hatchery Monitoring and Evaluation. Annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	Hayes, M.C., R.W. Carmichael, M.L. Keefe, and T.A. Whitesel. (1997). Accuracy of length estimates for chinook salmon and steelhead in compartmented and standard hatchery raceways. Progressive Fish Culturist 59:285-292.
☐	Groberg, W.J., Jr., N.L. Hurtado, S.T. Onjukka, and K. Waln. 1996a. Report B: Fish Health Monitoring and Evaluation in Umatilla Hatchery Monitoring and Evaluation. Annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	Groberg, W.J., Jr., S.T. Onjukka, and K. Waln. 1996b. Report B: Fish Health Monitoring and Evaluation in Umatilla Hatchery Monitoring and Evaluation. Annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	Keefe, M.L., R.W. Carmichael, R.A. French, W.J. Groberg, and M.C. Hayes. 1993. Umatilla hatchery monitoring and evaluation. Annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	Keefe, M.L., R.W. Carmichael, S.M. Focher, W.J. Groberg, and M.C. Hayes. 1994. Umatilla hatchery monitoring and evaluation. Annual progress report to Bonneville Power Administration, Portland, Oregon.
☒	Knapp, S.M., J.C. Kern, W.A. Cameron, S. M. Snedaker, and R.W. Carmichael. 1997. Evaluation of juvenile salmonid outmigration and survival in the lower Umatilla River basin. Annual progress report to Bonneville Power Administration, Portland, Oregon.
☐	NPPC (Northwest Power Planning Council). 1987. Columbia River basin fish and wildlife program (as amended). Northwest Power Planning Council,

	Portland, Oregon.
☐	NPPC (Northwest Power Planning Council). 1994. Columbia River basin fish and wildlife program. Northwest Power Planning Council, Portland, Oregon.
☐	Sokal R.R. and F.J. Rohlf. 1981. Biometry. W.H. Freeman and Company, New York.
☐	USBR (U.S. Bureau of Reclamation) and BPA (Bonneville Power Administration). 1989. Umatilla basin project. Initial project workplan presented to the Northwest Power Planning Council, May 1989.

PART II - NARRATIVE

Section 7. Abstract

Response:

Umatilla Hatchery is the foundation for rehabilitating chinook salmon and enhancing steelhead in the Umatilla River. Fish released in the Umatilla River are expected to contribute significantly to the NPPC doubling goal in the Columbia basin. Monitoring and evaluation of hatchery rearing is essential to achieving basin goals that include: 1) provide information for culture and release of hatchery fish, harvest regulations, and natural escapement that will lead to the accomplishment of long-term natural and hatchery production goals in the Umatilla River basin in a manner consistent with provisions of the Council's Fish and Wildlife program; and 2) assess the success of achieving the management objectives in the Umatilla River basin that are presented in the Master Plan and the Comprehensive Rehabilitation Plan. Hatchery studies focus on comparison of effectiveness and efficiency of producing fish in standard Oregon and oxygen-supplemented Michigan raceways with varying rearing and release strategies. Previous studies at Willamette Hatchery suggest a negative relationship between growth rate and rearing density for yearling spring chinook salmon reared in oxygen-supplemented Michigan raceways (Ewing et al. 1998). The scope of oxygen-supplemented rearing studies has been broadened at Umatilla Hatchery to include evaluations with summer steelhead, fall and spring chinook salmon. Adaptive management changes that resulted from this study leading to improved hatchery and fishery management include: 1) tagging of fall chinook salmon to reduce the effects of straying; 2) eliminating subyearling and fall releases of spring chinook salmon because of poor survival; 3) altering release times for steelhead to improve adult survival; 4) reducing steelhead rearing densities to improve fish health; 5) changes in fishing regulations based on creel survey data. Unforeseen water shortages at Umatilla Hatchery has increased the importance of developing an effective rearing program that maximizes smolt production and adult contributions. Experiments and methods follow the criteria established in the comprehensive study plan. Outcomes produced from this project will be: measurement and analyses of juvenile rearing performance, juvenile and adult survival, fish health, catch contribution to commercial, tribal, and sport fisheries, effects of mass marking and straying for chinook salmon and steelhead. Pre-project adult return goals developed in the late-1980's following several years of favorable ocean-rearing conditions are 21,000 fall chinook, 11,000 spring chinook, and 9,670 steelhead. A minimum of 15 years is expected to be required to meet goals for fall chinook salmon (2006)

Section 8. Project description

a. Technical and/or scientific background

Response:
Rehabilitation of anadromous fish stocks in the Umatilla River basin in northeastern Oregon includes the restoration of spring and fall races of chinook salmon *O. tshawytscha*, coho salmon *O. kisutch* and supplementation of summer steelhead *O. mykiss* (Boyce 1986). Increased populations of Umatilla River salmon and steelhead have resulted from artificial and natural production (CTUIR and ODFW 1990). These efforts were intended to provide offsite mitigation for Columbia River basin salmon losses (NPPC 1987). The Fisheries Restoration Program in the Umatilla River basin has produced adult returns that partially mitigate for lost fisheries (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b; Focher et al. 1997; Groberg 1996a 1996b, CTUIR 1994; Contor et al. 1995, 1996, 1997). Monitoring and evaluation studies have been implemented to determine the success of different hatchery rearing and release strategies that are ongoing and will require adult survival information before each study can be completed. The Comprehensive Plan (Boyce 1986) identified the need for evaluating survival of hatchery and natural smolts through the entire river basin. In addition, the FWP (NPPC 1994) specified that biological monitoring is needed to provide information for updating subbasin plans, for improving management and conservation of natural populations, for assessing the effectiveness of hatchery rearing and release strategies (including acclimation), and for supplementation research.

The project focuses on hatchery rearing factors that affect fish condition and health, the success of juvenile migration, adult survival, and fisheries contributions (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b; Focher et al. 1997, Groberg 1996ab). Specific objectives concentrate on the success of rearing fish at high densities using the "Michigan style" raceways that incorporate oxygen supplementation. If successful, the Michigan system will provide a method to rear more fish using less water at a lower cost. Other studies will monitor the effects of size-at-release, rearing density, and acclimation and an extensive marking program that is managed in consultation with section 7 of the Endangered Species Act for Snake River fall chinook salmon. Current research was developed to determine which rearing methods and strategies were appropriate for each stock used in the restoration program. We are currently in the seventh year of monitoring and evaluation activities.

The lead project biologist has worked on the project since 1992. Previous work consisted of research related to fish feeding success and management evaluations to determine the success of fishing regulations and fish stocking programs with the Minnesota Department of Natural Resources for a total 15 years in fisheries work. The assistant project biologist began work with the project in 1995 and has extensive experience in evaluating hatchery programs related to early rearing . The second assistant began work on the Umatilla in 1992 and has 15 years experience conducting fisheries and limnological studies.

b. Rationale and significance to Regional Programs

Response:
Results of research on the effectiveness of rearing salmon and steelhead in Michigan and Oregon raceways at Umatilla Hatchery may have significance to restoration and rearing programs throughout the Columbia basin and other areas with limited water supplies. The Michigan system is designed to rear fish at high densities using oxygen supplementation and has proven successful for increasing smolt production Willamette Hatchery, Oregon (Ewing et al. 1994). Adult returns at Willamette Hatchery have been lower than expected but studies have been limited to yearling spring chinook salmon (Ewing, personal communication). Michigan systems have not been thoroughly evaluated at other locations or for rearing fall chinook salmon and steelhead. If fish can be reared efficiently at high densities in Michigan raceways, significant savings may result in the

form of reduced construction, water, and production costs. In addition, unforeseen water shortages at Umatilla Hatchery have increased the importance of developing an effective rearing program that maximizes smolt production and adult contributions. Additional studies on size and time of release and acclimation will have application to other restoration and supplementation programs

The evaluation of rearing and survival success is critical to the restoration program in the Umatilla River and to the NNPC's doubling goal for the Columbia basin. Umatilla Fish Hatchery is the foundation for rehabilitating chinook and salmon and enhancing steelhead in the Umatilla River; therefore, analysis of the factors affecting juvenile and adult survival are needed to ensure program success.

Monitoring has shown that adult fall chinook salmon from releases made into the Umatilla River stray into the Snake River system. The tagging program annually wire-tags more than 3 million fish and early results show that significant numbers of fish can be removed before straying past Lower Granite Dam. Removal of strays assists the restoration program for the listed stocks of fall chinook salmon in the Snake River. Marking studies are incomplete, but have provided valuable information on the use of body-tags as a mass mark.

c. Relationships to other projects

Response:
Study scope and approach of this project was developed in conjunction with the Umatilla Hatchery Master Plan, the Umatilla Basin Natural Production Monitoring and Evaluation Plan and the Outmigration and Survival study. This project supplements monitoring efforts of the Natural Production M&E by monitoring and collecting biological information on returning adults. This activity meets measures 7.0C.4, 7.1C, and 7.4L.1 of the FWP. This project also supplements monitoring efforts of the Outmigration and Survival study by providing marked groups that can be identified to determine in-basin survival. This information is critical for adaptive management of hatchery programs. These activities meet measures 7.2D.1, 7.4I, and 7.4I.1 of the FWP.

Information obtained on juvenile rearing and migration, adult survival, and recreational fishing is shared with other projects, fish managers, and hatcheries. Information on rearing and survival data is used by state and federal agencies to improve hatchery programs throughout the Columbia basin. Information on stray fall chinook salmon is used by the state of Washington and the National Marine Fisheries Service to determine if fish releases and adult returns are compatible with the ESA plan for Snake River fall chinook salmon (meets measure 7.10A.2 of FWP). Monitoring adult recovery provides critical information needed to evaluate the effectiveness of the Umatilla Subbasin Habitat Improvement Project, Umatilla Hatchery Satellite Facilities, and the Umatilla River Trap and Haul Program.

Cooperation and collaboration among all parties and agencies involved in the Umatilla basin allows sharing of information to fill database gaps among projects and sharing of equipment, provides staff assistance during field sampling, and opportunities for participation in joint studies. Transfer of project information occurs to improve river operations, fine-tune operating criteria for specific facilities, and improve management decisions in the adaptive management process.

Project staff also involve local schools, private organizations, government agencies, and other scientists in their activities, either through field opportunities, classroom lectures, sharing of expertise, equipment, or information, or obtaining permission for specific work. We provide information to the National Marine Fisheries Service needed to develop management actions that reduce fall chinook salmon straying into the Snake River. We obtain specific database information necessary for project data analysis from the CTUIR, Fish Passage Center, Pacific States Marine Fisheries Commission, and the Washington Department of Fish and Wildlife. We require assistance from the Oregon State Police and the local county sheriff's department when hunting or fishing violations are observed during angler surveys.

d. **Project history** (for ongoing projects)

Response:
This project (9000500) has continued uninterrupted since 1992. Research objectives were developed from hatchery technical work group meetings, the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990), and a comprehensive plan for monitoring and evaluation (Carmichael 1990). We have completed 7 years of monitoring and evaluation of fish reared at Umatilla, Bonneville, Cascade, Irrigon, Little White Salmon, and Willard hatcheries (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b; Focher et al. 1997; Hayes et al. 1997, Carmichael 1997). Information collected to date includes data on fish health, juvenile rearing, migration, and water quality. Preliminary data on smolt-to-adult survival has been analyzed and used to make changes to the hatchery program. This information will be updated as data from from completed brood years is acquired.

Preliminary results indicate equal survival between fish reared in Michigan and Oregon raceways and within Michigan passes; however, analysis has been hampered by small sample size. If these trends continue, Michigan systems will be used to increase the smolt production and adult contributions of subyearling fall chinook salmon reared at Umatilla Hatchery compared with standard rearing strategies in Oregon raceways. Number of smolts produced per gallon of water was approximately three times greater in Michigan raceways than in standard Oregon raceways. Smolt-to-adult survival was low (0.01-0.03%) for the first two broods and well below Master Plan expectations of 0.3%. However, these goals were established following several years of favorable ocean-rearing conditions. Parallel trends in smolt-to-adult survival rates of subyearling fall chinook salmon released in the Umatilla River since 1982 and those released at Priest Rapids Hatchery, Washington suggest Master Plan goals will be met for broods that experience favorable ocean conditions. Smolt-to-adult survival for fish released during favorable ocean conditions in the mid-1980's averaged 0.7% for Umatilla River releases and 1.1% for Priest Rapids Hatchery releases. Smolt-to-adult survival has been higher for yearling fall chinook salmon compared with subyearlings, but still well below Master Plan goals. Yearling production has shifted to Bonneville Hatchery because increased survival and limited rearing space at Umatilla Hatchery. Michigan vs Oregon comparisons with yearling and subyearling indicated no difference in stress response and migration to John Day Dam, but descaling was higher in Michigan-reared fish. Annually, more than 3 million fall chinook salmon have been wire-tagged since 1994 to assist in the removal of strays from Lower Granite Dam. Initial data indicates that strays are being successfully removed.

Spring chinook salmon have been reared at Umatilla Hatchery as subyearlings for release in both the spring and fall, and as yearlings for spring release. Preliminary results from completed broods that have experienced poor ocean conditions indicate smolt-to-adult survival for all these rearing strategies has been lower than Master Plan expectations. Spring-released subyearlings were reared for two years to utilize the high growth rates that were predicted for the warm water at Umatilla Hatchery. However, growth rates were not as great as predicted and the program was discontinued due to extremely poor survival. Fall-released subyearlings were reared at Umatilla and Bonneville hatcheries to capitalize on unused rearing space. Smolt-to-adult survival of fall-released subyearlings has been higher for Bonneville fish compared with Umatilla fish and higher in one of three years than spring-released yearlings. Smolt-to-adult survival of yearlings are below Master Plan goals and 5 times greater for Bonneville-reared fish than Umatilla-reared fish. Differences in survival for yearlings between the two hatcheries may be associated with differences in seasonal temperature profiles or fish health. Lack of pronounced seasonal temperature changes at Umatilla Hatchery has prompted us to transfer a portion of the production upriver to evaluate whether cold-water overwintering will improve survival. There appeared to be no correlation between ATPase levels, smolt development, and migration success for yearlings. Smolt-to-adult survival has been similar between Michigan- and Oregon-reared fish. Recent releases have produced as many as 2,200 adults to the Umatilla River, and an associated recreational and tribal fisheries.

Seven brood years (1991-1997) of Umatilla stock summer steelhead have been reared in Michigan raceways at Umatilla Hatchery, acclimated at upriver sites, and released into the Umatilla River. Preliminary results from completed broods that have experienced poor ocean conditions indicate

smolt-to-adult survival (0.05-0.34%) has been lower than Master Plan expectations (2.7%). Smolt-to-adult survival has been higher for groups released in April compared to groups released in May. The original hatchery plan was to rear Wallowa stock steelhead in Oregon raceways at Umatilla Hatchery (instead of Irrigon Hatchery) to evaluate Michigan vs Oregon rearing, but this has not been possible due to water shortages. However, a gross measure of Michigan-reared steelhead performance may be possible. Smolt-to-adult survival of Michigan-reared steelhead raised at Umatilla Hatchery and released in the Umatilla River has been similar to Oregon-reared steelhead raised at neighboring Irrigon Hatchery and released in the Grande Ronde Basin. The condition of smolts reared in first, second, and third pass Michigan raceways has been similar to smolts reared in Oregon raceways at Irrigon Hatchery. Baffle-removal was implemented on one Michigan raceway in 1996-97 to evaluate effects on fish health.

Water quality has generally been similar in Michigan and Oregon raceways. Effects of poor water quality and rearing fish at high densities were reduced by using high turnover rates and oxygen supplementation at the head of each raceway. We removed the baffles from some Michigan raceways and increased water turnover and oxygen supplementation to improve water quality in some high-density rearing programs.

Surveys of the recreational fishery have shown that significant fisheries have been developed in the Umatilla River for salmon and steelhead. More than 12,000 angler-hours have been measured annually. Annual fisheries have been developed for coho and fall chinook salmon. In addition, sport seasons for spring chinook salmon have been possible in 5 of 8 years.

After five years of intensive monthly and preliberation monitoring no ectoparasites or viral agents have been detected on or in any juvenile salmonids reared at Umatilla Hatchery. Nor have environmental or bacterial gill disease been indicated at any time even though high density rearing occurs each year in Michigan raceways. Examinations of spring chinook salmon and steelhead has suggested little evidence for vertical transmission. Losses of juvenile spring chinook salmon from bacterial kidney disease (BKD) at Umatilla Hatchery has prompted implementation of a 100% BKD sampling of female broodstock and egg segregation program. Studies of the cold-water disease bacterium, *Flexibacter psychrophilus*, suggest that fish were infected through abrasions of the skin, possibly from the baffles in Michigan raceways. Baffles removal appears to reduce disease levels.

e. Proposal objectives

Response:

Individual program objectives are designed to answer specific problems that were described as biological critical uncertainties in the Umatilla Master Plan as follows:

Primary:

1. Can fish return goals to Threemile Falls Dam be achieved using hatchery production and supplementation?

2. To what extent can we use oxygen supplementation during rearing to increase the efficiency of producing summer steelhead and fall chinook for hatchery and natural production?

3. Will releases of subyearling and yearling spring chinook smolts produced at Umatilla Hatchery achieve the desired level of adult production?

4. To what extent can we use oxygen supplementation during rearing to increase the efficiency of producing spring chinook adults for hatchery and natural production?

5. Will returning adult fall chinook salmon from releases made in the Umatilla River stray beyond acceptable limits into the Snake River system?

6. To what extent are harvest objectives being achieved?

Secondary:

1. To what extent will acclimation of summer steelhead, fall chinook, and spring chinook smolts enhance smolt-to-adult survival and homing.

2. To what extent will rearing density influence efficiency of producing summer steelhead, fall chinook, and spring chinook adults in the standard and oxygen supplementation systems.

Biological priorities were established based on their effect on achievement of program goals and the systemwide application of results. At present there is limited natural reproduction of fall or spring chinook salmon in the basin, however, the success of restoration efforts to a large extent will be determined by the hatchery program. A substantial proportion of the production at Umatilla Hatchery is produced in the Michigan supplementation system. This rearing system has not been thoroughly evaluated to determine the effects on smolt-to-adult survival. Disease monitoring and evaluation is also a critical component.

Monitoring and evaluation of the hatchery provides critical information on all life stages of anadromous salmonids in the Umatilla basin. Broodstock development and egg-to-fry survival is evaluated to improve hatchery techniques. Fish reared at the hatchery are monitored for performance measures including health, ability to respond to stress, migration success, and achievement of size-at-release goals. Adult returns are monitored to determine success of different rearing methods and profiles, appropriateness of stocks, straying of fish to other basins, and contribution of hatchery releases to commercial, tribal, and sport fisheries in the Columbia Basin.

Program objectives:

1. Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of subyearling fall chinook salmon reared in Michigan and Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared in first, second, and third pass Michigan raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared in first and second pass Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared in Michigan or Oregon systems.
   Assumptions: Ability to rear fish to equal sizes in Michigan and Oregon passes and raceways. Ability to collect 35 wire-tagged fish per replicate to analyze life history and survival success. Expected survival rate to the Umatilla River is 0.30%. We expect to produce 11,500 adults for freshwater and ocean fisheries per million fish released.
   Products: Comparison of adult survival, fishery contribution, age at return, and cost for fish reared in Michigan and Oregon raceways.

2. Determine and compare rearing performance, smolt condition, juvenile migration performance, smolt-to-adult survival, life history characteristics, and cost effectiveness of subyearling fall chinook salmon reared at three densities in Michigan raceways
   Null hypothesis: Length, weight, condition factor, and food conversion are not significantly different among fall chinook salmon reared at three densities in Michigan raceways.
   Null hypothesis: Mean length, weight, condition factor, smoltification, and descaling are not significantly different among fish reared at three densities within Michigan raceways.
   Null hypothesis: Migration success and duration are not significantly different among fish reared at three densities within Michigan raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared at three densities within Michigan raceways.
   Assumptions: Ability to rear fish to equal sizes in Michigan passes. Ability to collect 35 juveniles and wire-tagged fish per replicate to analyze migration, life history, and survival success.

Products: Comparison of juvenile growth and condition, juvenile migration success, adult survival, fishery contribution, age at return, and cost for fish reared at three densities in Michigan. Expected survival rate to the Umatilla River is 0.30%. We expect to produce 11,500 adults for freshwater and ocean fisheries per million fish released.

3. Determine and compare rearing performance, smolt condition, juvenile migration performance, smolt-to-adult survival, life history characteristics, and cost effectiveness of yearling fall chinook salmon reared in Michigan or Oregon raceways at Umatilla Hatchery, and at Bonneville, Little White Salmon, and Willard hatcheries.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared in first, second, and third pass Michigan raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared in first and second pass Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared in Michigan and Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among fall chinook salmon reared at Umatilla, Bonneville, Little White Salmon, and Willard hatcheries.
   Assumptions: Ability to collect 35 wire-tagged fish per replicate to analyze life history and survival success.
   Products: Comparison of adult survival, fishery contribution, age at return, and cost for fish reared at Umatilla, Bonneville, Little White Salmon, and Willard hatcheries. Expected survival rate to the Umatilla River is 0.75%.

4. Determine and compare straying of fall chinook salmon into the Snake and upper Columbia rivers for all groups.
   Assumptions: Ability to effectively collect wire tagged fish in the Columbia and Snake River systems.
   Products: Estimates of straying of fall chinook released into the Snake River ESA unit. Estimates of effectiveness of wire-tagging, acclimation, and flow manipulation as means to reduce straying.

5. Determine the effects of tagging and marking on smolt-to-adult survival of subyearling fall chinook salmon.
   Assumptions: Ability to effectively collect wire tagged fish in the Columbia and Snake River systems.
   Products: Estimates of tag retention for blank-wire tags and smolt-to-adult survival of fish with different fin marks based on recoveries in the Umatilla River.

6. Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of subyearling spring chinook salmon reared in Michigan and Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared in first, second, and third pass Michigan raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared in first and second pass Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared in Michigan or Oregon systems.
   Assumptions: Ability to collect 35 wire-tagged fish per replicate to analyze life history and survival success. Expected survival rate to the Umatilla River is 0.30%. We expect to produce 3,900 adults for freshwater and ocean fisheries per million fish released.
   Products: Comparison of adult survival, fishery contribution, age at return, and cost for fish reared in Michigan and Oregon raceways.

7. Determine and compare smolt-to-adult survival, life history characteristics, and cost effectiveness of spring chinook salmon reared in Michigan or Oregon raceways at Umatilla and Bonneville hatcheries and released in the fall.
   Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared in first, second, and third pass Michigan raceways.

Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared in first and second pass Oregon raceways.
Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared in Michigan or Oregon systems.
Null hypothesis: Smolt-to-adult survival is not significantly different among spring chinook salmon reared at Umatilla or Bonneville hatcheries.
Assumptions: Ability to collect 35 wire-tagged fish per replicate to analyze life history and survival success. Expected survival rate to the Umatilla River is 0.50%.
Products: Comparison of adult survival, fishery contribution, age at return, and cost for fish reared in Michigan or Oregon raceways at Umatilla or Bonneville hatcheries.

8. Determine and compare rearing performance, smolt condition, juvenile migration performance, smolt-to-adult survival, life history characteristics, and cost effectiveness of yearling spring chinook salmon reared in Michigan and Oregon raceways.
   Null hypothesis: Mean length, weight, condition factor, food conversion, smoltification, and descaling are not significantly different among spring chinook salmon reared in Michigan and Oregon raceways.
   Null hypothesis: Migration success and duration are not significantly different among fish reared at in Michigan and Oregon raceways.
   Null hypothesis: Smolt-to-adult survival is not significantly different between spring chinook salmon reared in Michigan and Oregon raceways.
   Assumptions: Ability to rear fish to equal sizes in Michigan and Oregon raceways and passes. Ability to collect 35 juveniles and wire-tagged fish per replicate to analyze migration, life history, and survival success. Expected survival rate to the Umatilla River is 0.75%. We expect to produce 2,800 adults for freshwater and ocean fisheries per 210,000 fish released.
   Products: Comparison of juvenile growth and condition, juvenile migration success, adult survival, fishery contribution, age at return, and cost for fish reared in Michigan and Oregon raceways.

9. Determine and compare smolt condition, smolt migration performance, smolt-to-adult survival, and life history characteristics between yearling spring chinook salmon reared at Umatilla, Bonneville, Little White Salmon, and Carson hatcheries.
   Null hypothesis: Smoltification and descaling are not significantly different among spring chinook salmon reared at different hatcheries.
   Null hypothesis: Migration success and duration are not significantly different among fish reared at different hatcheries.
   Null hypothesis: Smolt-to-adult survival is not significantly different between spring chinook salmon reared at different hatcheries.
   Assumptions: Ability to collect 35 juveniles and wire-tagged fish per replicate to analyze migration, life history, and survival success.
   Products: Comparison of juvenile growth and condition, juvenile migration success, adult survival, fishery contribution, age at return, and cost for fish at different hatcheries. Expected survival rate to the Umatilla River is 0.75%. We expect to produce 2,800 adults for freshwater and ocean fisheries per 210,000 fish released.

10. Monitor rearing performance, smolt condition, smolt migration performance, smolt-to-adult survival, life history characteristics, and cost effectiveness of summer steelhead reared in Michigan raceways.
    Assumptions: Ability to collect 35 juveniles and wire-tagged fish per group to compare migration, life history, and survival success. Expected survival rate to the Umatilla River is 2.70%. We expect to produce 5,670 adults per 210,000 fish released.
    Products: Comparison of juvenile growth and condition, juvenile migration success, adult survival, fishery contribution, age at return, and cost for fish reared in Michigan raceways.

11. Summarize water quality monitoring in an index series of Michigan and Oregon raceways.
    Null hypothesis: Water quality parameters are not significantly different in Michigan and Oregon raceways used to rear salmon or steelhead.

Null hypothesis: Water quality parameters are not significantly different in Michigan passes used to rear salmon or steelhead.
Assumptions: Weekly collection of water quality data.
Products: Summary of data on inlet and outlet water temperature, oxygen, nitrogen, total pressure, pH, ammonia, and alkalinity in Michigan or Oregon raceways.

12. Coordinate in the development of a water quality sampling and monitoring program in the Umatilla basin.
Assumptions: None.
Products: Review of existing data to establishment of a water sampling program in the Umatilla basin.

13. Determine annual recreational fishery for chinook salmon and summer steelhead in the Umatilla River including estimates of catch by tag code.
Null hypothesis: None
Assumptions: We assume effort and catch data obtained from interviewing a subsample of anglers is representative of the fishery. Ability to count and interview anglers in river sections open to recreational fishing.
Products: Estimates of effort, catch, harvest, and number harvested by tag code for coho salmon, fall and spring chinook salmon, and steelhead fisheries.

14. Participate in planning and coordination activities associated with anadromous fish production and monitoring and evaluation in the Umatilla basin.
Null hypothesis: None
Assumptions: None.
Products: Participation in technical work groups to ensure coordination, experimental, and sampling needs are met.

15. Monitor and evaluate the health and disease status of spring and fall chinook salmon and summer steelhead juveniles released in the Umatilla River, adult broodstocks providing gametes for the Umatilla program, and CWT marked adults reared as juveniles at Umatilla Hatchery where possible.
Null hypothesis: None
Assumptions: Ability to collect representative samples of fish at hatchery to monitor fish health.
Products: Preliberation health examination for specific fish pathogens and parasites; implementation of disease control measures and recommendations of adjustments to rearing strategies; examinations of returning adults, including spawned fish, sacrificed fish, mortality, and carcasses on the spawning grounds for R. salmoninarum.

f. Methods

Response:
Detailed methods are available in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990), and in annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b; Focher et al. 1997; Hayes et al. 1998 in press, Groberg 1996ab).

Methods follow criteria detailed in the Master Plan, these criteria are:

1. Uncertainties should be evaluated in priority order.
2. Each treatment should be replicated twice within a year, preferably, three or four times.
3. Each treatment should be replicated four years to ensure performances are observed under a variety of environmental conditions. This should allow us to distinguish a minimum of 50% difference among treatments with 95% certainty.
4. At least one treatment (rearing and release strategy) for each species must be used as the standard control and maintained through time.

5. To minimize variation we require 35 observed coded-wire tag (CWT) mark recoveries per test group. This should give a coefficient of variation for smolt-to-adult survival of .25 (de Libero 1986; Mobrand 1987).
6. The same species must be reared in a raceway series where water is reused and each pass must be considered a separate treatment because of potential differences in water quality as water is modified by the degree of reuse.

Obj. (1-10) Juvenile rearing data will allow us to compare fish performance for groups reared under different rearing profiles. Growth is monitored by measuring 100 lengths and 50 weights of fish in each raceway each month. At pre-release fish 300 lengths and 100 weights and condition factors are measure from fish in each raceway. Smolt condition, including fin erosion, descaling, and smolt development are measured for 200 fish from each raceway prior to transfer and when the fish are released from acclimation ponds. When possible, data on juvenile rearing was analyzed with analysis of variance procedures (Sokal and Rohlf 1981).

Obj. (1-10) Results of juvenile tagging experiments will allow us to determine migration survival and performance for different rearing profiles. Juvenile migration data was collected from 1992-1997 by branding 5,000-10,000 fish from each raceways. Brand retention was evaluated for each group. Data was collected on migration timing and success by collection programs already in place at the John Day and Bonneville dams. Migration data was evaluated graphically or using binomial comparisons. We are currently PIT tagging approximately 10,000 fish to evaluate juvenile migration of Umatilla River releases. Approximately 250-500 fish per group will be PIT tagged to provide adequate data. Detection of PIT-tagged fish will occur in the Umatilla River at the lower river rotary trap, at West Extension Canal, and at Westland Canal during transport operations. Fish will also be interrogated at John Day and Bonneville dams.

Obj. (1-10) Adult survival data is collected through a database maintained by the Pacific States Marine Fisheries Commission. Tag data is used to determine contributions by brood year and release strategy We calculate total survival, survival to the Umatilla River, and exploitation based on expanded recovery data. We also use the database and completed brood years to evaluate straying rates from all locations in the Columbia basin.

Obj. (13) Monitoring the recreational fishery will provide information of fishery contribution of release groups and economic value of each program. Fishing is evaluated with standard survey methods. Sampling is conducted on 2-3 weekdays per week and on all weekends and holidays. Anglers are interviewed using a random access survey. Counts of anglers are made three times each day to estimate effort. All data including coded-wire tag expansions of fish caught is made using a statistical program developed by ODFW.

Obj. (15) Fish health monitoring provides critical information used to improve rearing strategies and juvenile and adult survival. Health is monitored by collecting fish from all raceways at all rearing facilities on a monthly basis. Kidney samples are collected from jack and adults salmon returning to the Umatilla River at collection sites or during spawning ground surveys. Analysis of variance is used for statistical analysis of cumulative percent monthly mortality and disease values. Drug and formalin treatments are administered and tested under Investigational New Animal Drug protocols

Obj. (12, 14) Coordination is used to reach goals, improve work efficiency, and avoid duplication of work within the basin. We will use coordination and information exchange processes currently established within the Umatilla Basin (Umatilla River Operations Group, Umatilla Passage Technical Work Group, Umatilla Monitoring and Evaluation Oversight Committee) to assist in project planning and coordination.

g. Facilities and equipment

Response:

1. *Fish rearing and condition data*: We will rear all fish at state, federal, or cooperatively managed hatcheries. Fish condition will be evaluated using measuring boards, scales, and visual evaluations of each fish sampled. Visual evaluations have been standardized to provide continuity between years and observers.

2. *Offices:* Laboratory space is used at Umatilla Hatchery. Office space in Hermiston currently occupies a 2,600 ft^2 suite.

3. *Technical Equipment*: Water quality is measured with a Common Sensing gas meter (model TBO-F) to monitor oxygen, nitrogen, and total pressure. The pH is measured with a hand-held meter. Alkalinity is determined by titration using standard methods. Ammonia is analyzed by a private laboratory. Hand-loop detectors are used to interrogate PIT tagged fish.

4. *Computer Equipment*: Three desk-top (386 + pentium 233) and one lap-top computer (386) are available for word processing, data summarization and analysis, and graphics development. An additional computer (386) is used to run the PIT tag station. MS Office is the standard software used.

5. *Marking Equipment*: CO_2-activated injectors to paint mark fish. Syringes and needles to PIT-tag fish. PIT tags will be purchased through the Pacific States Marine Fisheries Commission.

6. *Vehicles*: One 1/2 ton truck and one-sedan are used year-round for personnel, fish, and equipment transport. Vehicles are obtained from DAS.

h. Budget

Personnel costs are required for project management and field, laboratory, data analysis, and report writing tasks associated with PIT-tagging, coded-wire-tagging, creel surveys, water quality monitoring, and fish growth, condition, and health monitoring. Increases in personnel costs from previous years reflect cost-of-living and salary increases. Fringe benefits provide employee health insurance and agency personnel administration and support. Supplies and services are needed primarily to purchase wire-tags and PIT- tags, conduct marking and tagging operations, and operate offices and laboratories. Capital acquisition funds are needed to acquire or replace tagging and laboratory equipment, and upgrade office computers. Travel costs are needed to rent, operate, and maintain vehicles and cover per-diem expenses for travel to field sites, hatcheries, program-related meetings, and professional meetings. Indirect costs are required to provide agency business administration and support.

Section 9. Key personnel

Response:

Program Leader: Richard W. Carmichael; FTE = 0.16
Project Leader: Michael C. Hayes; FTE = 1
Ass't Project Leader: R. Wes Stonecypher; FTE = 1
Ass't Project Leader: William A. Cameron; FTE = 1
Seasonal workers: FTE = 1.0

Program Manager

Richard W. Carmichael

EDUCATION

1984 - M.S., Fisheries Science, Oregon State University, Corvallis, OR
1979 - B.S., Fisheries Science, Oregon State University, Corvallis, OR

EXPERIENCE

7/90 - Present **Program Leader - Executive Manager,** Oregon Department of Fish & Wildlife, 211 Inlow Hall, EOU, La Grande, OR 97850

Program leader - Executive manager for NE Oregon Fisheries Research and Development Program. Primary responsibilities are to develop and direct implementation of a complex research program to evaluate success of protecting, reestablishing, and restoring ESA listed and non-listed stocks in eastern Oregon, oversee 14 full-time fisheries biologists and up to 8 projects, and represent ODFW on regional and national scientific committees. Adjunct professor at Eastern Oregon University.

12/83 - 7/90 **Fish. Res. Leader**, Oregon Dept. Fish & Wildlife, La Grande, OR
3/83 - 12/83 **Fish Res. Ass't**, Oregon Dept. of Fish & Wildlife, La Grande, OR
10/82 - 3/83 **Project Asst.** Oregon Dept. of Fish & Wildlife, La Grande, OR

EXPERTISE

Expertise in fisheries research project development and implementation, personnel management, budget development and tracking, technical report writing, natural production and supplementation research, hatchery effectiveness, hatchery and wild fish interactions, life history, harvest assessment, stock assessment, passage evaluation, straying, captive broodstock, statistical analysis, coded-wire tag implementation and assessment, bass and trout ecology, creel censusing.

PUBLICATIONS

Carmichael, R.W. 1998. Status review of the spring chinook salmon hatchery program in the Grande Ronde River Basin, Oregon. Lower Snake River Compensation Plan Status Review Symposium, USFWS, Boise, ID.

Carmichael, R.W. 1998. Status review of the spring chinook salmon hatchery program in the Imnaha Ronde River Basin, Oregon. Lower Snake River Compensation Plan Status Review Symposium, USFWS, Boise, ID

Carmichael, R.W. 1997. Straying of Umatilla River hatchery origin fall chinook salmon into the Snake River. In: Genetic Effects of Straying of Non-Native Hatchery Fish into Natural Populations (W.S. Grant, editor). NOAA, Seattle, WA.

Carmichael, R.W. and R.T. Messmer. 1995. Status of supplementing chinook salmon natural production in the Imnaha River basin. *In* Uses and Effects of Cultured Fishes in Aquatic Ecosystems (H.L. Shramm, Jr., and R.G Piper, eds.).

Whitesel, T.A., P.T. Lofy, R.W. Carmichael, R.T. Messmer, M.W. Flesher, and D.W. Rondorf. 1994. A comparison of the performance of acclimated and direct stream released, hatchery-reared steelhead smolts in Northeast Oregon. Pages 87-92 *in* High Performance Fish (D.D. MacKinlay, ed.); Fish Physiology Section, American Fisheries Society, Fish Physiology Association, Vancouver, British Columbia, Canada.

Project Leader
Michael C. Hayes

EDUCATION

1982 M.S., Fisheries Science, New Mexico State University, Las Cruces, NM
1975 B.S., Natural Resources, University of California, Berkeley, CA

EXPERIENCE

06/95 - Present **Supervisory Fish & Wildlife Biologist**,
Oregon Department of Fish and Wildlife, 80866 Hwy 395 No., Hermiston, OR 97838

Project leader for the Umatilla Hatchery Monitoring and Evaluation Study. Primary responsibilities are to identify and oversee research goals and objectives, administer and coordinate project operations, develop and monitor project budget, conduct data analyses, prepare reports, presentations, and proposals, hire, train, and supervise project personnel, participate in collection of scientific data, manage a field office, participate in interagency planning/coordination meetings, and provide technical assistance to agency staff.

10/91 - 5/95	**Asst Project Leader**, Oregon Dept. Fish & Wildl., Hermiston, OR
6/85 - 8/91	**Fisheries specialist,** Minnesota DNR, Lake City
9/83 - 5/85	**Biologist**, Aquanautics Corp., Beaufort, N.C.
6/79 - 8/83	**Fishery Research Asst.,** New Mexico St. Univ. Las Cruces, N.M.

EXPERTISE

Seven years experience in hatchery rearing and release strategies on the Umatilla River focusing on factors affecting smolt condition and juvenile and adult survival. Five years experience in management of coldwater and coolwater streams, specializing in the evaluation of long-term management plans, stocking, and angling regulations. Four years experience in limnological measurements, invertebrate identification, and food foraging behavior.

PUBLICATIONS

Hayes, M. 1990. Evaluation of special regulations for a winter trout season on the Middle and South Branches of the Whitewater River. Minnesota Department of Natural Resources, F-29-R(P)-9, Study 4, Job 179.

Hayes, M.C., R.W. Carmichael, S.M. Focher, R.W. Stonecypher. 1997. Annual Report 1996, Umatilla Hatchery Monitoring and Evaluation. Bonneville Power Administration (Project 90-005), Portland, OR.

Hayes, M.C., L.A. Gates, and S.A. Hirsch. (1997). Multiple catches of smallmouth bass in a special regulation fishery. North American Journal of Fisheries Management, 17:182-187.

Hayes, M.C., R.W. Carmichael, M.L. Keefe, and T.A. Whitesel. (1997). Accuracy of length estimates for chinook salmon and steelhead in compartmented and standard hatchery raceways. Progressive Fish Culturist 59:285-292.

Assistant Project Leader
William A. Cameron

EDUCATION

1990 - M.S., Fisheries Biology, Oregon State University.
1982 - B.S., Fisheries Biology, Humboldt State University.

EXPERIENCE

2/92 - Present **Fishery Biologist** (Assistant Project Leader), Oregon Dept. Fish & Wildlife, 80866 Hwy 395, Hermiston, OR 97838

Assistant project leader for Umatilla Hatchery Monitoring and Evaluation Study. Duties include monitoring growth, health, juvenile migration success, and adult survival for hatchery reared salmon and steelhead. Additional duties include overseeing PIT-tag operations and sport fishery creel survey. Also conduct data analyses, prepare reports, presentations, and proposals, train and oversee project personnel, participate in collection of scientific data, participate in interagency planning/coordination meetings, and provide technical assistance to agency staff.

5/91 - 2/92 **Fishery Biologist**, U.S. Forest Service, McKenzie Bridge, OR 97413
10/88 - 1/91 **Research Assistant**, NPS Coop. Park Study Unit, O.S.U., Corvallis, OR 97331
6/87 - 10/87 **Experimental Biological Aid**, NPS Coop. Park Study Unit, O.S.U., Corvallis, OR
6/84 - 4/87 **Fisheries Researcher**, Northern SE Regional Aquaculture Assoc., Sitka, AK 99835
5/83 - 9/83 **Biological Aide**, California Dept. Fish & Game, Burney, CA
4/82 - 9/82 **Field Assistant**, City of Arcata, Marsh Pilot Project, Arcata, CA 95221

EXPERTISE

Fifteen years of work experience conducting fisheries and limnological studies. Completed studies and written reports on juvenile salmonid outmigration and survival, juvenile salmonid passage at fish bypasses and ladders, resident fish populations in streams, assessments of bull trout stream restoration projects, effects of warm springs on the physical, chemical, and biological characteristics of lakes and streams, effects of inorganic nutrient additions to the physical, chemical, and biological characteristics of a lake ecosystem and it's capacity to produce salmon smolts. Extensive experience operating juvenile fish traps, marking fish, collecting and analyzing fisheries data and water samples, operating scientific instruments in the field and laboratory, conducting statistical analyses, and writing reports.

PUBLICATIONS

Cameron, W.A., S.M. Knapp, and R.W. Carmichael. 1997. Evaluation of juvenile salmonid bypass facilities and passage at water diversions on the lower Umatilla River. Final report to Bonneville Power Administration, Portland, Oregon (DOE/BP-01385-7).

Cameron, W.A. and G.L. Larson. 1993. Limnology of a caldera lake influenced by hydrothermal processes. Arch. Hydrobiol. 128 (1): 13-38.

Cameron, W.A. and G.L. Larson. 1991. Baseline inventory of the aquatic resources of Aniakchak National Monument, Alaska. Final report to National Park Service, Anchorage, Alaska.

Cameron, W.A. 1990. Responses to fertilization and fish stocking in the pelagic ecosystem of a naturally fishless lake. Final report to Northern SE Regional Aquaculture Assoc, Sitka, AK.

Assistant Project Leader
R. Wes Stonecypher

EDUCATION

1992 M.S., Zoology and Physiology, University of Wyoming, Laramie, WY
1989 M.S., Wildlife Ecology, Mississippi State University, Starkville, MS
1985 B.S., Biology, Washington State University, Pullman, WA

EXPERIENCE

8/95 - Present **Natural Resource Specialist** (Assistant Project Leader), Oregon Dept. Fish & Wildlife, 80866 Hwy 395, Hermiston, OR 97838

Assistant project leader for Umatilla Hatchery Monitoring and Evaluation Study. Duties include monitoring growth, health, juvenile migration success, and adult survival for hatchery reared salmon and steelhead. Additional duties include monitoring egg survival and database management. Also conduct data analyses, prepare reports, presentations, and proposals, train and oversee project personnel, participate in collection of scientific data, participate in interagency planning/coordination meetings, and provide technical assistance to agency staff.

6/94-10/95	**Experimental Biological Assistant**, Oregon Dept. of Fish and Wildlife, OR
3/92-10/93	**Fish Biologist**, Shoshoni-Bannock Tribes, Fort Hall, ID
7/91-3/92	**Research Technician**, University of Wyoming, Laramie, WY
8/89-6/91	**Research Assistant**, Wyoming Coop, Fish and Wildlife Research Unit, Laramie, WY
2/89-8/89	**Fisheries Technician**, Dept. of Wildlife and Fisheries, MSU, Starkville, MS
8/86-12/88	**Research Assistant**, Mississippi Ag. Forestry Expt. Station, MSU, Starkville, MS
2/86-8/86	**Technician**, Weyerhaeuser Timber Co., Environmental Research, Centralia, WA

EXPERTISE

Ten years experience in warm or cold water fish production. Fish sampling experience including: snorkeling, fyke, gill, and hoop netting, spawning boxes and seining. Fish work includes: anesthetizing, freeze and heat branding, chilling embryos to prolong development, starch gel electrophoresis and heavy metal toxicity testing. Additional experience in collecting and analyzing fisheries data and conducting spawning ground surveys. Operation of scientific instruments in the field and laboratory, conducting statistical analyses, and writing reports.

PUBLICATIONS

Stonecypher, R. Wes, Jr., J.D. Fernandez, W.A. Hubert, and W.A. Gern. 1992. Increased copper concentration in water from chilling units with copper evaporator coils. Progressive Fish Culturist 54:61-63

Stonecypher, R. Wes, Jr, W.A. Hubert, and W.A. Gern. 1992. Effect of reduced incubation temperatures on survival of trout embryos. Progressive Fish Culturist 56:180-184.

Focher, S.M., R.W. Carmichael, M.C. Hayes, and R.W. Stonecypher, Jr. 1997. Umatilla hatchery monitoring and evaluation. 1996 annual progress report to Bonneville Power Administration, Portland, Oregon.

Section 10. Information/technology transfer

Response:
Progress reports will be written annually and distributed to those on the BPA publications distribution list. Final completion reports are written at the conclusion of the project and distributed similar to annual progress reports. Journal articles are being developed on specific aspects of the project and on the final report. Results are presented at Umatilla Passage Technical Work Group meetings, Umatilla Monitoring and Evaluation Oversight Committee meetings, and Umatilla River Operations Group meetings. A Umatilla basin research review is to be held in early 1998, covering most research projects within the basin. Presentations are given at AFS meetings, special workshops, and CBFWA and BPA public reviews.

Congratulations!